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INTERMOUNTAIN FOREST & RANGE EXPERIMENT STATION  
Ogden, Utah



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SITE PREPARATION AIDS NATURAL REGENERATION IN  
WESTERN LARCH-ENGELMANN SPRUCE STRIP CLEARCUTTINGS

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## THE AUTHORS

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## INTRODUCTION

Much has been written concerning the seedbed requirements for efficient natural regeneration of Engelmann spruce (Picea engelmannii Parry), western larch (Larix occidentalis Nutt.) and their associated species (Lowdermilk 1925, Barr 1930, Smith 1955, Day 1964, Roe 1952, Roe and DeJarnette 1965, and Alexander 1966). Seedling establishment is favored by the exposure of mineral soil through scarification and, to a lesser extent, by burning. It is generally agreed that some sort of seedbed preparation is necessary for prompt and adequate reproduction. But what is the best way to create the optimum environmental conditions? Is the scarification that results from logging sufficient--or should additional mechanical scarification be used? Is prescribed broadcast burning more efficient? Can the composition of the future stand be controlled by modifications of the site-preparation measures? These were the objectives of a cooperative study started in a northern Idaho larch-spruce stand in 1954.<sup>1</sup>

## STUDY AREA

The study area is located on Roundtop Mountain in the St. Joe National Forest in northern Idaho. The entire study area is on a northerly aspect at an elevation of 5,200 to 5,800 feet and is representative of the Picea-Abies/Menziesia habitat type (Daubenmire 1952).<sup>2</sup>

The existing mature stand was over 200 years old and averaged approximately 13 MBF per acre. Composition of the main merchantable stand, based on the number of trees per acre, was as follows:

<u>Species</u>	<u>Occurrence in total stand</u>
Western larch ( <u>Larix occidentalis</u> Nutt.)	56%
Engelmann spruce ( <u>Picea engelmannii</u> Parry)	22%
Mountain hemlock ( <u>Tsuga mertensiana</u> (Bong.) Carr.)	15%
Subalpine fir ( <u>Abies lasiocarpa</u> (Hook.) Nutt.)	7%

Minor amounts of Douglas-fir (Pseudotsuga menziesii (Mirb.) Franco), western white pine (Pinus monticola Dougl.) and grand fir (Abies grandis (Dougl.) Lindl.) were also present. Stands were rather open with an almost continuous undergrowth of false huckleberry (Menziesia ferruginea Sm.).

Approximately one-half of the volume on the area was harvested in 1951-53 by the strip-clearcutting method. The cut strips averaged 640 feet in width and 2,200 feet in length, with the long axis extending up and down the slope and in a north-south direction (fig. 1). The intervening uncut strips were approximately the same size.

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<sup>1</sup>Cooperators included: Potlatch Forests, Inc.; the St. Joe National Forest; the University of Idaho College of Forestry; and the Northern Pacific Railway Company.

The study was designed by C. A. Wellner. Initial measurements were made by R. F. Watt.

<sup>2</sup>The area would be reclassified as Tsuga mertensiana/Menziesia according to revisions in classification planned by Dr. Daubenmire (personal communication).

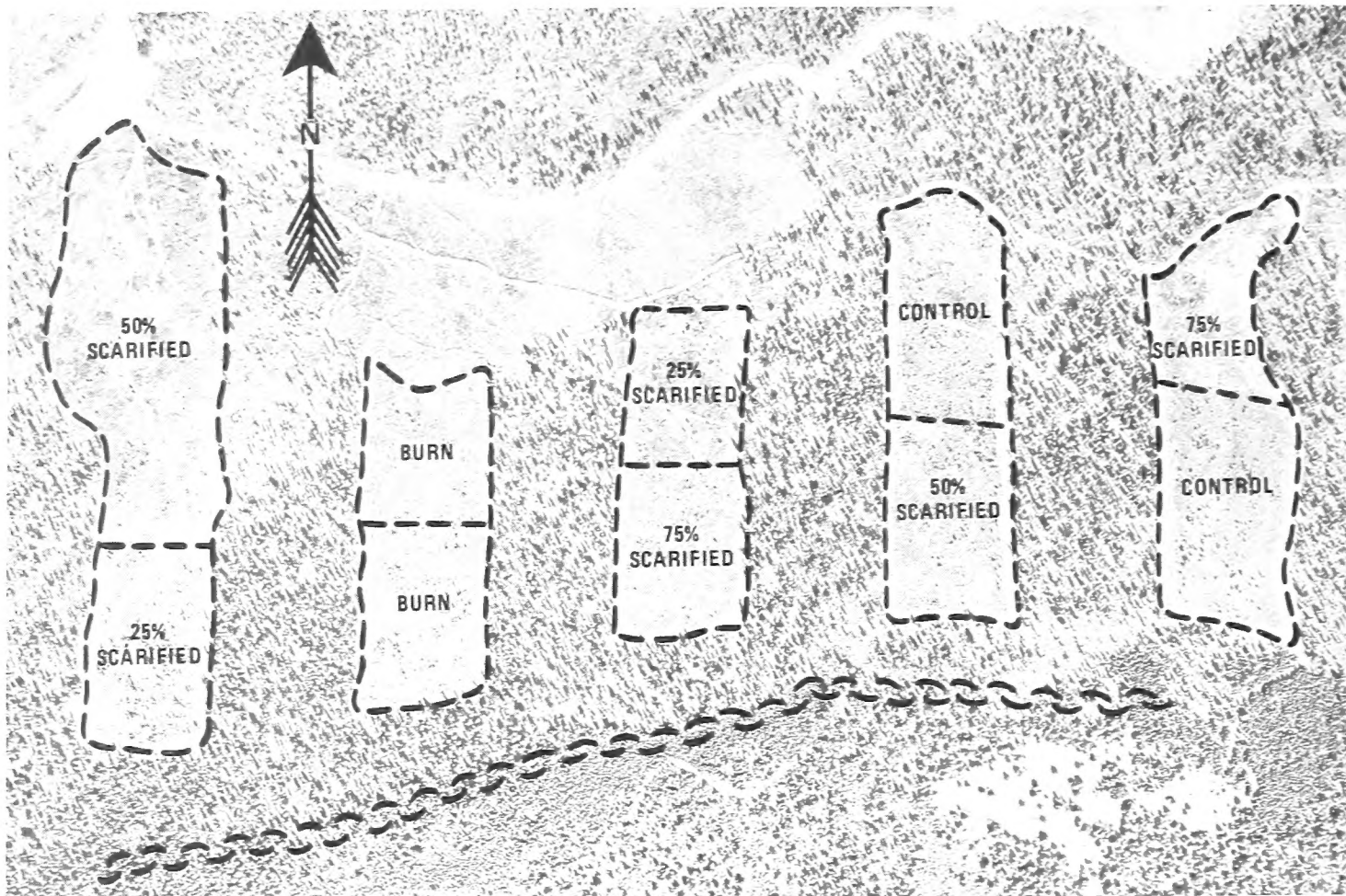


Figure 1.--Aerial photograph of study area showing clearcut strips and treatment areas.  
(Courtesy Potlatch Forests, Inc.)

Cutting did not extend to the crest of the ridge, so the top of each cut strip was bordered by uncut timber. Timber from the study area was cat-skidded in tree-lengths to landings at the foot of the strips. During the fall of 1954, several site preparation treatments were carried out to test their effectiveness in promoting subsequent natural regeneration on the clearcut strips.

#### STUDY METHODS

Site-preparation treatments assigned to the clearcut strips were as follows:

1. Control--no further disturbance.
2. Prescribed broadcast burning.
3. Light scarification--25% of the area bulldozer-scarified.
4. Moderate scarification--50% of the area bulldozer-scarified.
5. Heavy scarification--75% of the area bulldozer-scarified.

Some seed had been already dispersed by trees in the uncut strips before site preparation began. Broadcast burning was done on September 10, early in the seed dissemination season. Scarification was accomplished during the period of September 10 to September 18, 1954 with a D-7 crawler tractor equipped with a brush blade. Heavy slash accumulations from the bulldozer work were burned in late September and early October, probably after seed dissemination was nearly complete.

We have no seedfall records on the study area itself, but records were kept from 1952 to 1960 on a 15-acre clearcut block located about 1/2 mile north and at a slightly

lower elevation. These records indicate that spruce, subalpine fir and western larch seed production in 1954 was exceptionally good (table 1). Just how much of this may have been destroyed on the study areas by site preparation treatments is unknown.

Each of the five strips was divided at mid-slope into two different treatment areas, providing upper- and lower-slope replications for each treatment. Treatments were assigned at random within upper- and lower-slope replications with the restriction that both burn treatments would occupy the same strip. Before and after treatment, surveys were made to determine how well each treatment modified the seedling environment. Point-samples were taken every 5 links along transects located diagonally across each treatment area. Vegetation types (tall shrubs, low shrubs, and herbaceous) and seed-bed conditions (mineral, burned-mineral, and undisturbed) were recorded at each point.

To determine how effectively the treatments aided natural regeneration, reproduction surveys were made during the summer of 1960 using two random transects in each of the treatment areas. Transects were oriented east-west, perpendicular to the cutting line. Reproduction was recorded within concentric, circular 1- and 4-milacre plots spaced 1/2-chain apart along the transect lines. Only 3-year-old and older seedlings were tallied as established reproduction. The advance reproduction and subsequent reproduction were recorded separately, by species. No attempt was made to evaluate the production potential of the advance regeneration. Four-milacre stocking was determined on the basis of presence and dominance of species. A complete reproduction record was made on the 1-milacre unit to provide per-acre estimates of the potential stand. Visual estimates of vegetation cover and soil-surface conditions were also made on the 1-milacre units.

Statistical analysis was made where results were not obvious. Results of these analyses are reported in the text as "significant" or "nonsignificant" based on a 95 percent confidence level.

Table 1.--Seed production during a 9-year period near the Roundtop Mountain study area<sup>1</sup>

Year	Western larch	Douglas- fir	Engelmann spruce	Subalpine fir <sup>2</sup>
-----Thousands of seed per acre-----				
1952	1.7	10.2	11.1	1.2
1953	--	0.4	2.6	0.6
1954	17.6	10.4	232.6	6.3
1955-56				
(2-year total)	19.6	20.4	27.2	9.0
1957	4.7	3.0	1.1	0.2
1958-60				
(3-year total)	2.8	10.6	66.2	1.5

<sup>1</sup>Data provided by Potlatch Forests, Inc.

<sup>2</sup>Includes some grand fir.

## RESULTS

### Environmental Modifications

Although the study treatments called for 25, 50, and 75 percent scarifications, actual levels of 22, 39, and 52 percent were obtained, as measured by mineral soil exposure. Fifty-three percent of the broadcast-burned area had mineral soil exposed after burning (fig. 2).

Site preparation, either by burning or scarification, slowed the recovery of tall shrub cover but had little effect on low shrubs and herbs. The overall effect, however, was a general decrease in competition between tree reproduction and other vegetative growth on the treated plots. Burning and heavy scarification were the most effective in reducing this competition.

Five years later, invasion of vegetation had nearly obliterated all early post-treatment differences in seedbed conditions. The proportion of non-vegetated area on the treated plots was reduced to approximately 30 percent regardless of treatment as compared to 20 percent on the control area (fig. 2). Most of the regrowth was in the tall-shrub category which increased from an average of 26 percent coverage in 1955 to 44 percent coverage in 1960.

### Reproduction

The five different treatments produced no significant differences in stocking on the 4-milacre plots, if all tree species were considered and no distinction was made between advance and subsequent reproduction. On this basis, stocking varied from 73

*Figure 2.--Seedbed conditions before and after treatment, and 5 years later.*

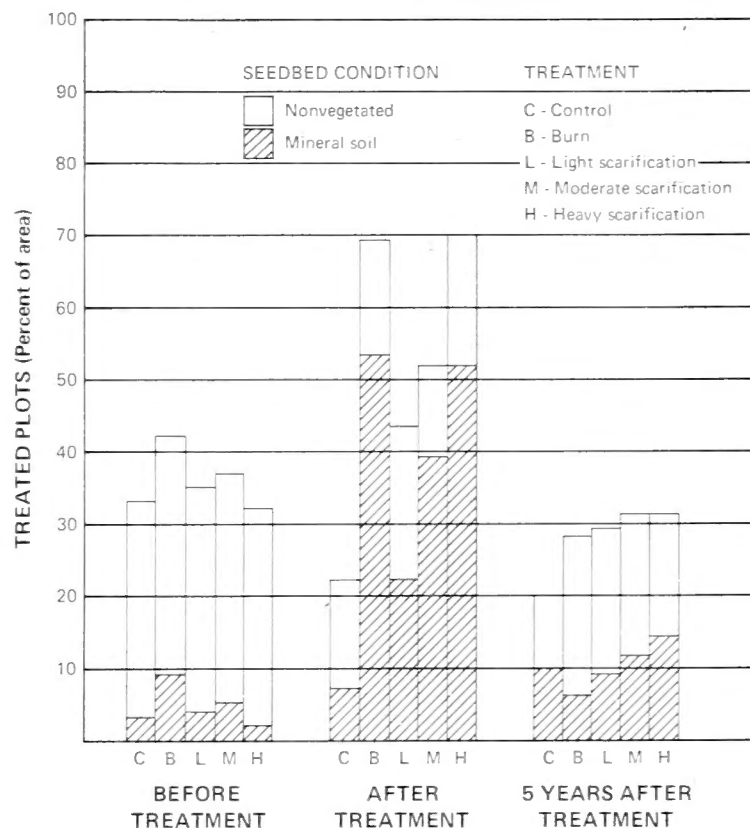
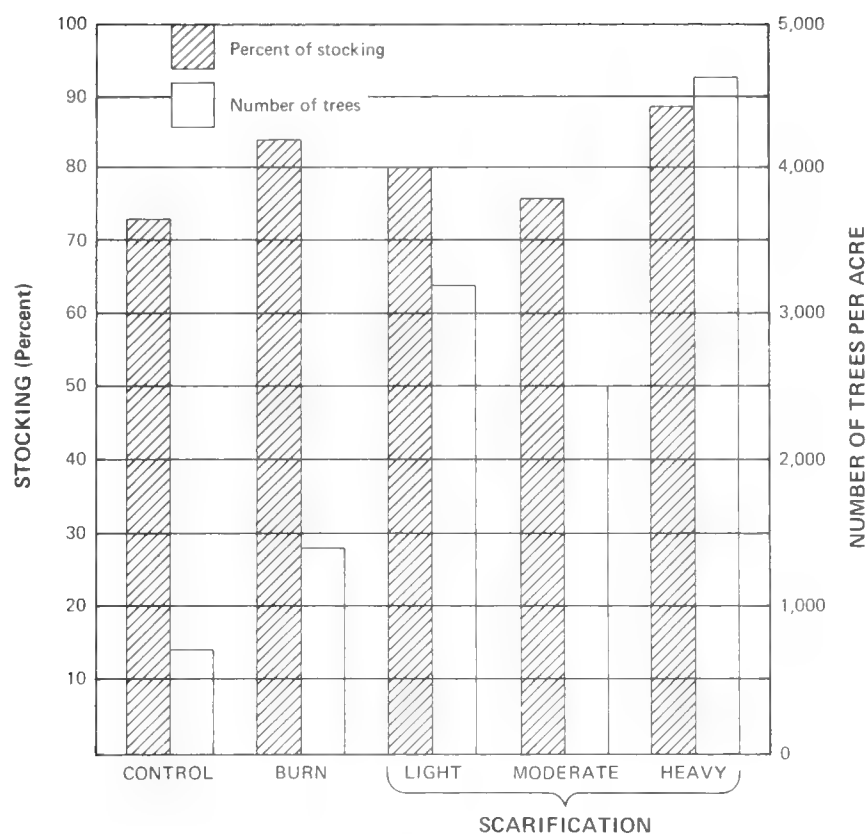


Figure 3.--Stocking percent and number of trees per acre (all species, advance and subsequent) 6 years after treatment.



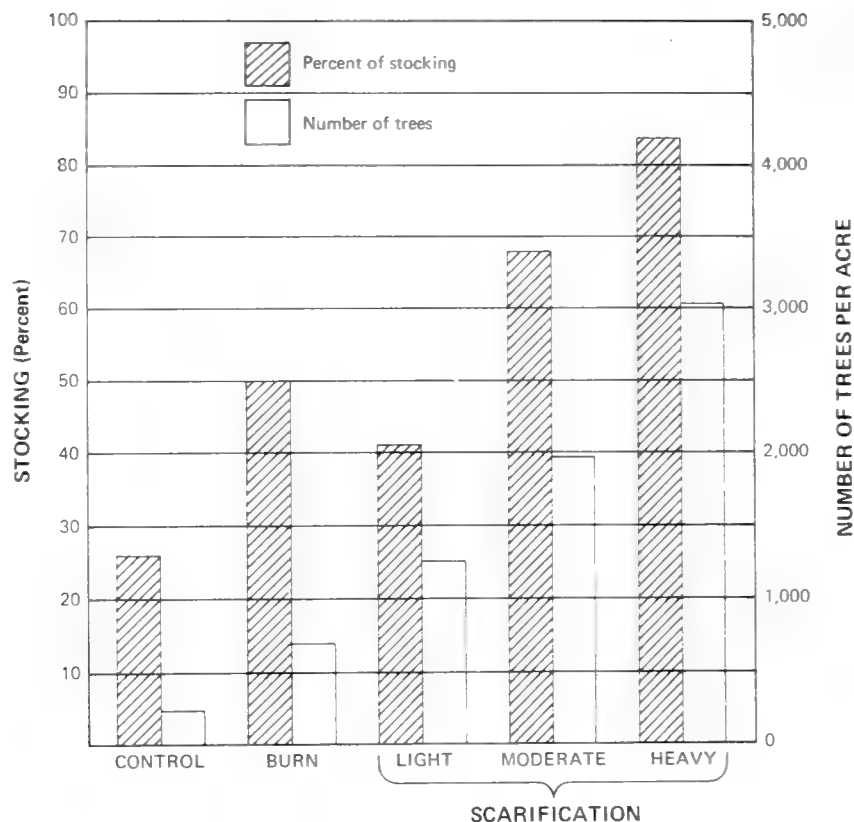
percent on the control plots to 89 percent on the area most heavily scarified (fig. 3). Since a 4-milacre stocking of 65 percent has customarily been considered adequate in this region, the gross stocking of reproduction reached satisfactory levels in all treatments. On the other hand, the number of trees per acre were quite markedly affected by treatment. Both the control plots and the burned areas were well stocked with surprisingly few total trees per acre; this indicates good distribution with a minimum of clumping.

From the standpoint of future merchantability, advance reproduction of subalpine fir, mountain hemlock, and even Engelmann spruce may have questionable merit because of poor form and susceptibility to rot. There is some question as to what extent these trees can contribute to establishment of a productive new stand; however, such contribution would certainly be highly variable. Widespread injury to advance growth frequently accompanies logging and supplemental site preparation measures. This injury provides many opportunities for rot infection among susceptible species. Day and Duffy (1963), for instance, estimated that only 7 percent of the advance subalpine fir and spruce reproduction had "good potential" in southwestern Alberta cutover stands. On the other hand, Roe and Schmidt<sup>3</sup> in a survey of logged areas in southern Idaho, western Wyoming, and Utah, found that an average of 37 percent of advance subalpine fir and 60 percent of advance Engelmann spruce had "good management potential."

There is some doubt also as to the future economic value of subalpine fir and mountain hemlock, even when free from early suppression and injury. Because of their susceptibility to heart rot and because of the low values attached to these species in

<sup>3</sup>Roe, Arthur L. and Wyman C. Schmidt. Factors affecting natural regeneration of spruce in the Intermountain Region. Unpublished manuscript, Intermountain Forest and Range Exp. Sta.

Figure 4.--Stocking percent and number of trees per acre ("most desirable" species only) 6 years after treatment.



comparison to others, most timber managers prefer to use regeneration measures that tend to discourage them as major components, but accept them as minor components of new stands (LeBarron and Jemison 1953, Smith 1955, Day and Duffy 1963). With these two considerations in mind, an analysis was made in which the spruce, larch, Douglas-fir and grand fir were selected as the "most desirable" species. This approach eliminated most of the advance reproduction since it was predominantly subalpine fir and mountain hemlock.

Stocking computed on this basis shows significant differences in stocking obtained by the five site preparation treatments (fig. 4). Burning resulted in 50-percent stocking in terms of the "most desirable" stand component; the untreated control produced only 26 percent stocking. On the three sites that received bulldozer scarifications, stocking varied directly with the degree of scarification--from a low of 41 percent where lightly scarified to 82 percent on areas that were heavily scarified.

Number of trees per acre of the "most desirable" components of the reproduction stand varied from 224 trees per acre on the untreated area to 3,000 trees per acre on the sites that received heavy scarification (fig. 4). On the burned area, a relatively small total number of seedlings (690 per acre) resulted in a rather high 4-milacre stocking of 50 percent. On the bulldozer-scarified plots the distribution of reproduction is definitely patchy--a mosaic of heavily overstocked areas and some understocked portions.

An appraisal of the contribution of each species and class of reproduction is presented in figure 5 which depicts by species and site preparation the 4-milacre stocking and the number of trees per acre of advance and subsequent reproduction. These results are discussed by individual species in the following paragraphs. Since no survey was made to determine the amount and distribution of advance reproduction on the study area prior to treatment, differences in the occurrence of these trees afterwards may not accurately reflect treatment effects.

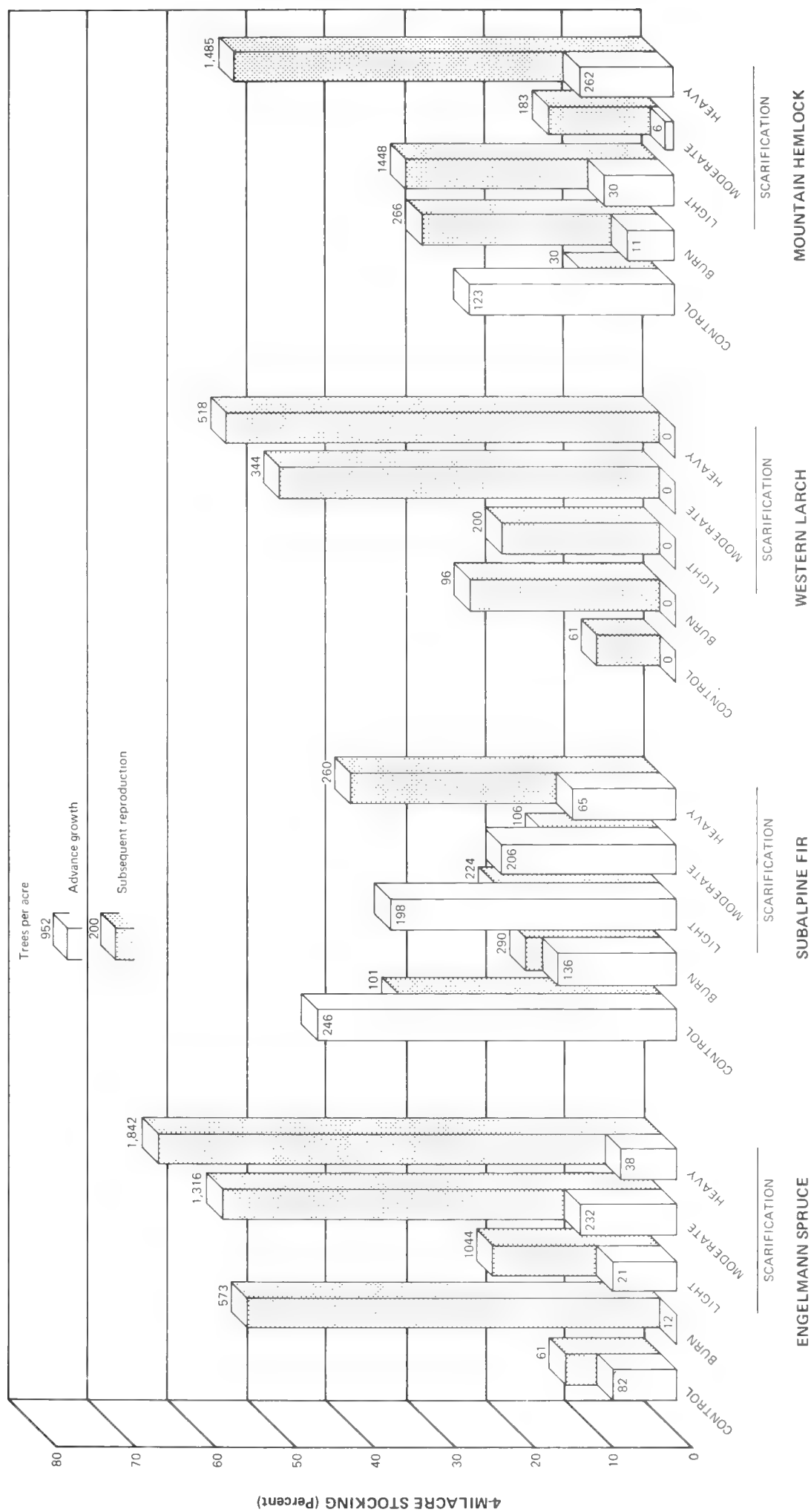


Figure 5.--Stocking of advance and subsequent reproduction of four major species by site preparation treatments.

## Engelmann Spruce

Subsequent regeneration of spruce was strongly influenced by site-preparation treatments. Stocking to new spruce seedlings was greater than 50 percent on plots that were burned and also on those given moderate to heavy scarification. Scarified plots averaged over 1,000 seedlings per acre, distributed fairly well except on the lightly scarified plots. The best distribution of spruce reproduction was obtained on the burned areas where a stocking of over 50 percent was obtained with an average of 573 seedlings per acre.

The ratio of spruce to subalpine fir reproduction was increased by site preparation. Scarification was especially discriminative, producing from 5 to 12 times more spruce seedlings per acre than subalpine fir. Spruce/fir ratios for control and burned areas were 0.6 and 2.0, respectively.

## Subalpine fir

On the control areas, subalpine fir was the most abundant and widely distributed species in terms of both advance and subsequent reproduction. Advance seedlings of subalpine fir outnumbered those of spruce by about 3 to 1. Subsequent subalpine fir seedlings held nearly a 2 to 1 advantage. Site preparation generally resulted in additional subalpine fir regeneration, but increases were smaller than with other species and stocking levels were either reduced or remained constant.

## Western Larch

As the intolerant nature of western larch would suggest, there was no advance regeneration of this species. Following clearcutting, only 8 percent of the control area became stocked with larch. Burning and light scarification resulted in larch stocking of 20 percent, or more; moderate and heavy scarification gave further improvement amounting to an additional 20 percent. This amount of larch regeneration, particularly on the burned area, was surprisingly small in comparison to that obtained on similarly prepared areas in the western larch--Douglas-fir type in western Montana (Roe 1952). However, the good distribution and rapid growth of the larch seedlings have added much to its importance. For instance, on the heavily scarified sites, larch was the dominant tree on 37 percent of the stocked plots while constituting only 11 percent of the total reproduction stand.

Although burning did not result in as much larch reproduction as was produced by other treatments, the larch seedlings were better distributed in relation to their number. Four-mile-acre stocking on burned areas equaled that on light scarification areas, but with about half as many seedlings per acre.

## Mountain Hemlock

The mountain hemlock seed source was "patchy" and this caused considerable variation in restocking results; however, it is evident that hemlock seedling establishment was benefited by site preparation. Subsequent regeneration of this species was second only to spruce except on the moderately scarified plots. Hemlock and subalpine fir together constitute approximately 82 percent of the advance growth and 53 percent of the new stand on the control plots.

## DISCUSSION AND CONCLUSIONS

It seems evident that both prescribed broadcast burning and mechanical scarification have their place as aids to the establishment of natural regeneration in the larch-fir type. Burning has the advantage of being usable over a wider range of topographic conditions. It also seems to create conditions more favorable for obtaining acceptable stocking with fewer seedlings, thus reducing future expenditures for cleaning and thinning. If advance growth is considered undesirable, burning will more effectively eliminate it from the future stand. While valid direct comparisons of site preparation costs are difficult to make, USDA Forest Service Region 1 cost analyses currently show that site preparation by machine-piling, scarification and pile-burning is, on the average, 25 percent more costly than slashing and prescribed burning.<sup>4</sup>

Machine scarification has the advantages of being flexible enough to: (1) permit preservation of much of the advance growth as part of the future stand while creating favorable conditions elsewhere for subsequent reproduction; and (2) permit better timing of the site preparation to take full advantage of natural seed dispersal without fear of destroying part of the important first seed crop. Risks to men and adjacent timber are likely to be less with bulldozer scarification than with prescribed broadcast burning.

Probably the most difficult decision facing the timber manager occurs when suitable advance growth is present. Then, it is not a choice between burning or scarification, but whether to rely on the advance growth at no additional establishment cost, or to prepare the site for new reproduction. Should the advance stand have a reasonably good future after logging, it may be unwise to spend money to destroy it in favor of new reproduction. It would seem that additional research is needed to help develop standards for appraising the production potential and management requirements of stands with a large component of advance growth.

Although the site preparation in this study did not appreciably improve the stocking levels, it certainly increased the diversity of stand components and, consequently, the diversity of management opportunities. Where no special site preparation was applied, the reproduction stand was composed predominantly of advance subalpine fir and mountain hemlock; such a stand tends to become highly defective and provides rather limited alternatives for future management. Burning or scarification have increased these management alternatives by providing stands composed mainly of subsequent reproduction of the same three species plus an important addition of western larch and a small amount of Douglas-fir and grand fir. Furthermore, the broader species' mixture may permit more efficient utilization of the site and provide a stand which is less susceptible to serious damage.

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<sup>4</sup>Personal communication, USDA Forest Service Region 1 Division of Timber Management.

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In northern Idaho, site-preparation methods following strip-clearcutting in western larch-Engelmann spruce had important effects on the character and amount of natural regeneration. While the percentage of stocked 4-milacre quadrats, counting both advance and subsequent reproduction, was not particularly affected, the entry of new seedlings and increased representation of intolerant species were promoted by prescribed broadcast burning and by scarification of the seedbed. Management opportunities and alternatives will be considerably improved in this more diversified reproduction stand.

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